PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P/3363-13	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US03/40940	International filing date *(day/month/year)* 18 December 2003 (18.12.2003)	Priority date *(day/month/year)* 20 December 2002 (20.12.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): F16C 017/04; B60G 015/06 and US Cl.: 267/219,220; 280/124.155; 384/228,241,420,422,424		
Applicant FAG KUGELFISCHER & CO. KG		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 11 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☒ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13 July 2004 (13.07.2004)	05 April 2005 (05.04.2005)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Thomas J. Williams Telephone No. 703-308-1113

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/40940

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description:
pages 2,8 as originally filed
pages NONE, filed with the demand
pages 1, 3-7, filed with the letter of 15 February 2005 (15.02.2005).

☒ the claims:
pages NONE, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages 9-13, filed with the letter of 15 February 2005 (15.02.2005).

☒ the drawings:
pages 1-16, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☒ the claims, Nos. 29-32

☐ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*
*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/40940

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims 1-23, 25-27	YES
	Claims 24 and 28	NO
Inventive Step (IS)	Claims 1-23, 25-27	YES
	Claims 24 and 28	NO
Industrial Applicability (IA)	Claims 1-28	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS

Claims 24 and 28 lack novelty under PCT Article 33(2) as being anticipated by JP 10-122,233 to Ueno et al. (or Aida et al.).

Re-claim 24, Ueno et al. discloses a ring bearing comprising: an upper casing 5; a lower casing 21; a plastic ring 4 is engaged between the casings; the upper and lower casing define upper and lower annular facing surfaces for engaging the plastic ring; the upper 52 and lower 62 facing surfaces have radially inner and outer portions, see figure 1; the inner and outer portions will have respective flat surfaces (when viewed at small integrals) which together define a V-shape when seen in cross section, the plastic ring has a corresponding cross-sectional V-shape.

Re-claim 28, the ring bearing is part of an upper strut mount, which will have the structure recited by the applicant.

Claims 1-23 and 25-27 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest a ring bearing having a plastic ring engaged between an upper and lower casing defining upper and lower facing surfaces being substantially curved between inner and outer portions of the casings, wherein the plastic ring is provided with upper and lower spacing portions centrally located between the inner and outer portions of the upper and lower curved facing surfaces; or the plastic ring having radially inner and outer portions that are enlarged, and wherein the ring has a spacing portion centrally located between the inner and outer portions of one of the upper and lower facing surfaces.

---------- NEW CITATIONS ----------

JP 07279948 A (MINEO) 27 October 1995, see figure 1.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
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VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No Patent No.	Publication Date *(day/month/year)*	Filing Date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
WO 2004070220 A1	19 August 2004 (19.08.2004)	05 February 2004 (05.02.2004)	07 February 2003 (07.02.2003)
JP 2004239379 A	26 August 2004 (26.08.2004)	07 February 2003 (07.02.2003)	None

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

PLASTIC RING BEARING, PARTICULARLY FOR USE IN MACPHERSON STRUT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims priority of U.S. provisional application serial number 60/435,978, filed December 20, 2002, the disclosure of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The invention relates to a ring bearing for use in a MacPherson strut, and more particularly to a ring bearing made of plastic.

Background Art

[0002] As shown in Figure 1, a MacPherson strut assembly has a strut tube 5, and a lower spring seat 4 welded to the strut tube 5. A spring 6 is positioned directly on the spring seat 4, or may be seated in a rubber dampener which is positioned on the spring seat 4. The latter reduces the road vibration transmitted from the wheels. The upper end of the spring 6 is held by the upper spring seat 1 which can also utilize a rubber dampening medium 3. A bearing 2 is captured in the upper spring seat 1 and keeps the upper seat 1 concentric to the strut tube 5. The upper seat 1 is interference fitted into the bore of the bearing 2.

[0003] An example of a known bearing 2 is described in detail in connection with Fig. 2. It supports the loads which are transferred through the spring 4 in a dual path arrangement and supports the loads from the spring 4 and strut tube 5 in a single path system.

[0004] The bearing 2 (Fig. 2) comprises upper and lower plastic casings 8 and 9. The arm extensions 8a, 8b, 8c, 8d, 9a, 9b provide a sealing function and on one side (8d) a locking feature. A set of balls 10 ride on two hardened steel raceways 11a, 11b. The raceways may be shaped corresponding to the curvature of the balls 10, or may be stamped in approximately a Gothic arch shape, for example. The latter shape

[0012] In a second embodiment, the sections are designed to carry the load over a defined angle. The bearing operates as an arc-contact bearing. This bearing reduces sideways travel of the casings and possibly squeaking and vibration.

[0013] According to a third embodiment, further improvement is obtained with a four-arc contact bearing.

[0014] In a fourth embodiment, the sections are designed to carry the load over a defined angle. This bearing operates as a combination of a line-contact bearing and an arc-contact bearing.

[0015] A fifth embodiment is designed to carry the load over a defined angle and operates as a four-point contact bearing.

[0016] A sixth embodiment is designed to carry the load over a defined angle and operates as a taper-line-contact bearing.

[0017] Other features and advantages of the present invention will become apparent from the following description of several embodiments of the invention which refers to the accompanying drawings.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0018] First Embodiment - Point Contact Bearing

The bearing 15 is depicted in Figures 4 and 5. It may have the same strut bearing upper casing 8 (plastic cap) and lower casing 9 (plastic base) as in Figs. 1-2. The prior art steel raceways 11a, 11b and rolling elements 10 have been replaced by a plastic ring 20. The ring 20 is profiled to establish a point contact bearing which is capable of supporting axial load. The upper and lower casings 8 and 9 and the plastic ring 20 each have a single radius. The radius of the upper and lower casings is R_2 while the radius of the ring 20 is R_1, wherein $R_1 < R_2$.

[0019] The ring also may have longitudinal grooves in its top and bottom surfaces as seen for example in Figures 12-14, which would eliminate contact at the central point where the ring 20 meets the upper and lower casings. This would reduce the friction of the assembly.

[0020] The ring also may have recesses in its top and bottom sides again as seen for example in Figures 12-14, which are used to carry lubrication. The lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

The design is economical due to the elimination of steel raceways and balls.

[0021] The radius of the plastic ring and the upper/lower casing (i.e. R_1 and R_2) can be adjusted according to the required load capacity. The weight of the bearing is reduced while maintaining the fitting diameters prescribed by the mating components. The rolling action of the balls is replaced by a sliding action which may be between two dissimilar plastic chemistries. The retained lubricant supplies sealing and continued lubrication through the life of the bearing.

[0022] Second Embodiment - Arc-Contact Bearing

The second embodiment of a bearing 25 is depicted in Figures 6 and 7, Figure 6 being a partly broken-away perspective view and Figure 7 being a partial cross-section. It has the same strut bearing upper casing (plastic cap) 8 and lower casing (plastic base) 9 as in Figures 4-5. The prior art steel raceways and rolling elements have been replaced by a plastic ring 30. Said ring 30 is profiled to establish an arc-contact bearing which is capable of supporting radial and axial loads. A contact interface of single radius R is formed between the upper and lower casings and the plastic ring 30.

[0023] The ring may have central longitudinal grooves at its top and bottom surfaces as seen for example in Figures 12-14 to eliminate contact where the ring meets the arches of the upper and lower casings. This feature would keep the friction of the assembly low.

[0024] The ring 30 also has recesses 32, 34 on its top and bottom sides which are used to carry lubrication. Said lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

[0025] An economical design is achieved due to the elimination of steel raceways and balls. The prior art weight of the bearing is reduced while maintaining the fitting diameters prescribed by the mating components. The rolling action of the balls is replaced by a sliding action, which may be between two dissimilar plastic chemistries. The retained lubricant supplies sealing and continued lubrication through the life of the bearing.

[0026] Third Embodiment

Another arc-contact bearing 35 is depicted in Figures 8 and 9. It has the same strut bearing upper casing (plastic cap) 8 and lower casing (plastic base) 9 as in Figures 4-5. The prior art steel raceways and rolling elements have been replaced by a plastic ring 40. Said ring is profiled to establish a four-arc contact bearing which is capable of supporting radial and axial loads. Contact betwcen the ring 40 and the upper and lower casings 8 and 9 is provided by both the ring and the casings having a single radius R_1, over an angular range defined by $\alpha <$ contact angle $< \beta$.

[0027] The ring 40 also has flattened top and bottom surfaces, leaving spaces between the top and bottom of the ring and the upper and lower casings. The ring also may have longitudinal grooves in its top and bottom surfaces as seen for example in Figures 12-14. These arrangements eliminate central contact where the ring meets the upper and lower casings, keeping the friction of the assembly low.

[0028] The ring also has rccesses on its top and bottom sides, again as seen for example in Figures 12-14, which are used to carry lubrication. Said lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

[0029] The design is economical achieved due to the elimination of steel raceways and balls. The parameters (i.e. R_1, R_2, R_3, α and β) can be adjusted to achieve the required axial and radial load capacity. The weight of the bearing is reduced while maintaining the fitting diameters prescribed by the mating components. The rolling action of the balls is replaced by a sliding action, which may be between two dissimilar plastic chemistries. The retained lubricant supplies sealing and continued lubrication through the life of the bearing.

[0030] Fourth Embodiment - Line/Arc Contact Bearing

The fourth bearing 45 is depicted in Figures 10 and 11. It has a strut bearing upper casing (plastic cap) 8a and lower casing (plastic base) 9a similar to those in Figures 4-5, with modifications as follows. The prior art steel raceways and rolling elements have been replaced by a plastic ring 50. Said ring 50 is profiled to establish a line/arc contact bearing which is capable of supporting radial and axial loads. The contact is provided by the casings 8a and 9a and the ring 50 having a single radius R, over an angular range defined by $\alpha <$ contact angle $< \beta$.

[0031] The ring also has longitudinal grooves 52, 54 at its top and bottom surfaces to eliminate the possibility of contact in the center regions of the upper and lower casings 8a, 9a. This will keep the friction of the assembly low.

[0032] The upper and lower casings 8a, 9a have respective projections 56, 58 which project into the grooves 52, 54, respectively.

[0033] The ring also has recesses on its top and bottom sides as shown for example in Figures 12-14 which are used to carry lubrication. Said lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

[0031] The design is economical due to the elimination of steel raceways and balls. The parameters (i.e. R, α and β) can be adjusted in response to the desired axial and radial load capacity. The weight of the bearing is reduced while maintaining the fitting diameters prescribed by the mating components. The rolling action of the balls is replaced by a sliding action, which may be between two dissimilar plastic chemistries. The retained lubricant supplies sealing and continued lubrication through the life of the bearing.

[0032] Fifth Embodiment - Bearing with Spring Seat

A fifth bearing 55 is shown in Figures 12-14. As shown in Figure 12, the bearing itself is shown fitted into a representative upper spring seat 1a corresponding to the upper spring seat 1 shown in Figure 1. It is retained in the seat 1a by the use of plastic ears 56 on the lower bearing casing 9b which are snapped under rubber tabs 57 on the vulcanized steel spring seat 1a.

[0033] In Figure 13, the bearing 55 is depicted in cross-section. Figure 14 is a partly broken-away perspective view. It has a strut bearing upper casing or plastic cap 8 similar to that in Figures 4-5. The lower section or plastic base 9b is similar to that in Figures 4-5, with modifications as described above.

[0034] The prior art steel raceways and rolling elements have been replaced by a plastic ring 60. Said ring 60 is profiled to establish a four-point contact bearing at its top and bottom, inner and outer corners which is capable of supporting radial and axial loads. The ring also has central grooves 62, 64 formed in its top and bottom surfaces to eliminate contact where the ring 60 meets the upper and lower casings 8, 9b. This reduces the friction of the assembly.

[0035] The ring also has recesses 66, 68 on its top and bottom sides which are used to carry lubrication. Said lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

[0036] The weight of the bearing is reduced while maintaining the fitting diameters prescribed by the mating components. The rolling action of the balls is replaced by a sliding action, which may be between two dissimilar plastic chemistries. The retained lubricant supplies sealing and continued lubrication through the life of the bearing.

[0037] Sixth Embodiment

A sixth bearing is depicted in Figures 15 and 16. It has a strut bearing upper casing (plastic cap) 8c and lower casing (plastic base) 9c. The prior art steel raceways and rolling elements have been replaced by a plastic ring 70. Said ring 70 is generally V-shaped in cross-section and is profiled to establish a multiple-point contact bearing which is capable of supporting axial load. The upper, lower casings 8c, 9c and plastic ring 70 have substantially flat interfaces 71, 72, 73, 74 at their upper and lower, inner and outer regions. A flat central face 75 is formed on the top surface of the ring 70, forming an angle α with the interface 71 and an angle $180° - \alpha$ with the interface 73. A flat central face 76 is formed on the upper surface of the lower casing 9c, forming an angle β with the interface 74 and an angle $180° - \beta$ with the interface 72. The flat surfaces 75, 76 form gaps between the ring 70 and the top and bottom casings 8c, 9c to eliminate contact at the central portions where the ring and the upper and lower casings meet. This will keep the friction of the assembly low.

[0038] Additional recessess 77 are formed in other respective surfaces of the ring 70 which carry lubrication and further reduce friction.

[0039] The ring also has recesses on its top and bottom sides as seen for example in Figure 12-14 which are used to carry lubrication. Said lubrication reduces friction and aids in the sealing of the bearing for improved lifetime.

[0040] The design is economical due to the elimination of steel raceways and balls. The design parameters, i.e. α and β, can be modified to improve axial and radial load capacity. α may be greater than β as shown in Figure 16, or α and β may have another relationship.

WHAT IS CLAIMED IS

1. A ring bearing, comprising:

an upper casing;

a lower casing; and

a plastic ring engaged between the upper and lower casings, thereby forming said ring bearing;

said upper and lower casings respectively defining upper and lower annular facing surfaces for engaging said plastic ring therebetween;

said upper and lower facing surfaces each having radially inner and outer portions;

said upper and lower facing surfaces each being substantially curved in a direction between said inner and outer portions thereof;

said plastic ring having upper and lower spacing portions, each being centrally located between said inner and outer portions of said upper and lower facing surfaces, thereby defining respective spaces oriented longitudinally of said ring between said plastic ring and said upper and lower facing surfaces which reduce contact friction with the respective facing surfaces.

2. The ring bearing of claim 1, further comprising additional grooves or recesses in the upper and/or lower surfaces of the plastic ring which further reduce contact friction with the respective facing surfaces of the upper and lower casings.

3. The ring bearing of claim 1, wherein said respective facing surfaces of said ring have at least in part a smaller radius of curvature than said facing surfaces of said casings.

4. The ring bearing of claim 1, wherein said respective facing surfaces of said ring have at least in part the same radius of curvature as said facing surfaces of said casings.

5. The ring bearing of claim 1, wherein said respective facing surfaces of said casings and said ring are engaged primarily at said inner and outer portions thereof.

6. The ring bearing of claim 1, wherein said spacing portion is defined by a flattened portion of said ring facing the corresponding said upper or lower facing surface.

7. The ring bearing of claim 1, wherein said spacing portion is defined by a groove formed in said ring facing the corresponding said upper or lower facing surface.

8. The ring bearing of claim 7, wherein one of said upper and lower facing surfaces has a respective projection which projects into the corresponding groove formed in the ring.

9. The ring bearing of claim 1, wherein said spacing portion is defined by a recess formed in said ring facing the corresponding said upper or lower facing surface.

10. A MacPherson strut having an upper spring seat, a spring, a strut tube, and a ring bearing disposed for engaging the spring seat, the spring and the strut tube; wherein the ring bearing comprises the ring bearing of claim 1.

11. The MacPherson strut of claim 10, further comprising additional grooves or recesses in the upper and/or lower surfaces of the plastic ring which further reduce contact friction with the respective facing surfaces of the upper and lower casings.

12. The MacPherson strut of claim 10, wherein said respective facing surfaces of said ring have at least in part a smaller radius of curvature than said facing surfaces of said casings.

13. The MacPherson strut of claim 10, wherein said respective facing surfaces of said ring have at least in part the same radius of curvature as said facing surfaces of said casings.

14. The MacPherson strut of claim 10, wherein said respective facing surfaces of said casings and said ring are engaged primarily at said inner and outer portions thereof.

15. A ring bearing, comprising:

an upper casing;

a lower casing; and

a plastic ring engaged between the upper and lower casings, thereby forming said ring bearing;

said upper and lower casings respectively defining upper and lower annular facing surfaces for engaging said plastic ring therebetween;

said upper and lower facing surfaces each having radially inner and outer portions;

wherein said ring has radially outer and inner portions which are relatively enlarged, in a direction between said upper and lower facing surfaces, with respect to a radially central portion thereof;

said plastic ring having a spacing portion, centrally located between said inner and outer portions of one of said upper and lower facing surfaces, thereby defining a respective space oriented longitudinally of said ring between said plastic ring and said one of said upper and lower facing surfaces which reduces contact friction with the respective facing surface.

16. The ring bearing of claim 15, wherein said spacing portion is defined by a flattened portion of said ring facing the corresponding said upper or lower facing surface.

17. The ring bearing of claim 15, wherein said spacing portion is defined by a groove formed in said ring facing the corresponding said upper or lower facing surface.

AMENDED SHEET

18. The ring bearing of claim 17, wherein said one of said upper and lower facing surfaces has a respective projection which projects into the corresponding groove formed in the ring.

19. The ring bearing of claim 15, wherein said spacing portion is defined by a recess formed in said ring facing the corresponding said upper or lower facing surface.

20. The ring bearing of claim 15, wherein said ring is generally dumbbell-shaped when seen in cross-section.

21. The ring bearing of claim 15, wherein said plastic ring has another spacing portion, centrally located between said inner and outer portions of the other one of said upper and lower facing surfaces, thereby defining a respective space oriented longitudinally of said ring between said plastic ring and said other one of said upper and lower facing surfaces which reduces contact friction with the respective central facing surface.

22. The ring bearing of claim 21, wherein the other one of said upper and lower facing surfaces has a respective projection which projects into the corresponding space between the facing surface and the ring.

23. A MacPherson strut having an upper spring seat, a spring, a strut tube, and a ring bearing disposed for engaging the spring seat, the spring and the strut tube; wherein the ring bearing comprises the ring bearing of claim 15.

24. A ring bearing, comprising:

an upper casing;

a lower casing; and

a plastic ring engaged between the upper and lower casings, thereby forming said ring bearing;

said upper and lower casings respectively defining upper and lower annular facing surfaces for engaging said plastic ring therebetween;

said upper and lower facing surfaces each having radially inner and outer portions;

wherein said inner and outer portions of each of said upper and lower facing surfaces have respective flat portions which together define a general V-shape when seen in cross-section, and said plastic ring has a corresponding cross-sectional V-shape.

25. The ring bearing of claim 24, said plastic ring having upper and lower spacing portions, each being centrally located between said inner and outer portions of said upper and lower facing surfaces, thereby defining respective spaces oriented longitudinally of said ring between said plastic ring and said upper and lower facing surfaces which reduce contact friction with the respective facing surfaces.

26. The ring bearing of claim 25, further comprising upper and lower spacing portions formed in said upper and lower facing surfaces, opposite said corresponding portions formed in said ring.

27. The ring bearing of claim 24, wherein said upper and lower facing surfaces have respective upper and lower spacing portions, each being centrally located between said inner and outer portions of said upper and lower facing surfaces, thereby defining respective spaces oriented longitudinally of said ring between said plastic ring and said upper and lower facing surfaces which reduce contact friction with the respective facing surfaces.

28. A MacPherson strut having an upper spring seat, a spring, a strut tube, and a ring bearing disposed for engaging the spring seat, the spring and the strut tube; wherein the ring bearing comprises the ring bearing of claim 24.